



JAXA developed SLR Reflector Mt.FUJI and Technical Demonstration on HTV-X

Japan Aerospace Exploration Agency

○Yuki Akiyama, Sachiyo Kasho, Masato Watanabe,
Kiyoshi Hamada, Shinichi Nakamura

e-mail: akiyama.yuuki@jaxa.jp

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Outline



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2. Background
3. Overview of Mt.FUJI Mission
4. To ILRS members

1. Purpose of this presentation



- Why I am here?
 - To explain “Mt.FUJI Mission” for which ILRS SLR campaign is essential to achieve its goal
 - To get official confirmation from ILRS people that this mission is worthy of the ILRS supports

- Note:
 - Mission Support Request is under preparation and submitted soon.

2. Background



- As space becomes more crowded, the importance of **ADR (active debris removal)** and **SSA (space situational awareness)** is increasing. In ADR, it is important to grasp the orbit and rotational motion of debris before approaching to the debris.
- Rader/optical observations are common way to do this, but not sufficient resolutions for orbital/attitude estimation. So JAXA is focusing on **SLR (satellite laser ranging)** to grasp the orbital and **rotational motion of debris**.
- If all space objects have an SLR reflector, the visibility from the ground (or trackability) is ensured even after they become debris, resulting in keeping better orbital and rotational motion grasps.
- However, conventional reflectors are **large, heavy, and expensive**. This is one of the cause not so many satellites have an SLR reflector. That's why we developed a **small, light-wight, and inexpensive** SLR reflector, **Mt.FUJI!!**



Item	Specification
Target attitude (circular orbit)	≤ 800 km
Diameter	112 mm
Height	32 mm
Mass	260 g
CCR size	1 inch (25.4 mm)
Number of CCR	7
FOV of Mt.FUJI	45 degrees (each CCR with 15 degrees)

Mt.FUJI

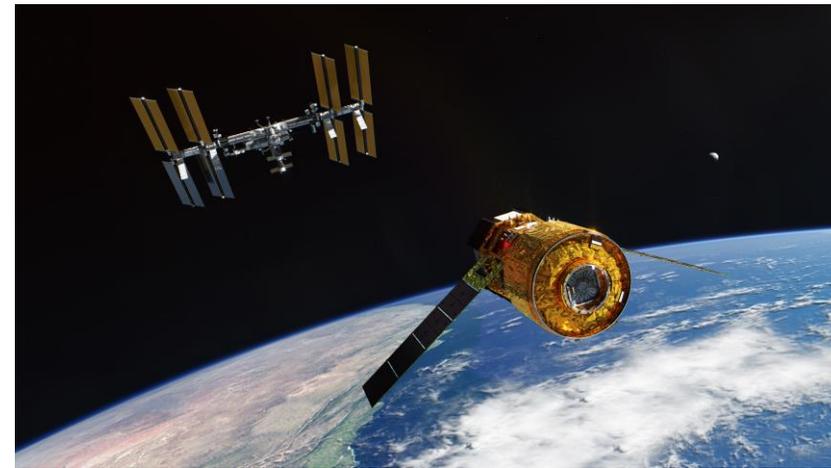
JAXA developed SLR Reflector with the concept of small, light-weight and inexpensive

3. Overview of Mt.FUJI Mission



Mt.FUJI

JAXA developed SLR Reflector with the concept of small, light-weight and inexpensive



HTV-X

JAXA developed new unmanned spacecraft as the successor to the HTV (Kounotori)

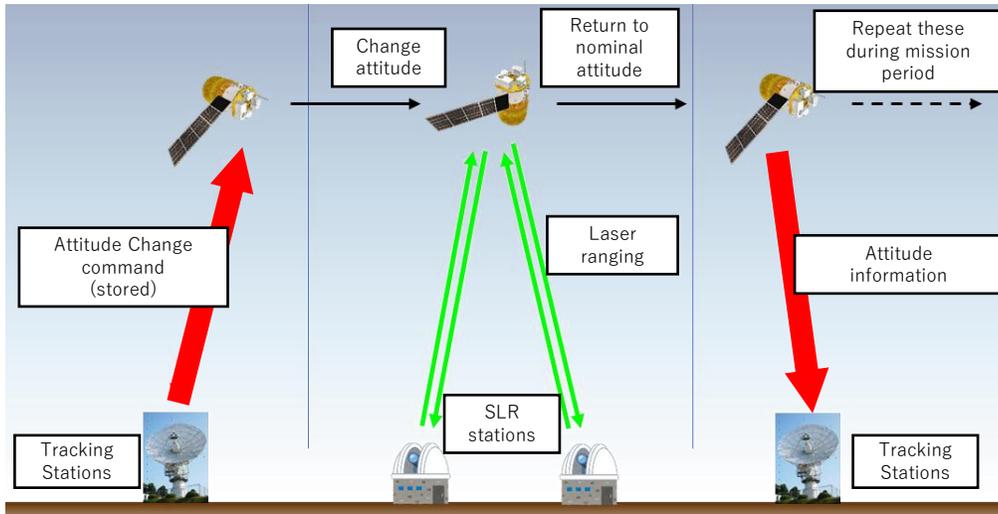
- In Mt.FUJI Mission, 3 Mt.FUJIs are mounted onto the backside of the HTV-X and fly in orbit!
 - Launch in FY2022 and start Mt.FUJI mission as early as April 2023 (planned)
- The missions of the HTV-X are:
 - transporting cargoes to the ISS
 - providing experiment platform. After departure of the ISS, 3 different technical demonstrations will be performed
- The objectives of Mt.FUJI mission are:
 1. to verify Mt.FUJI in orbit → detect return signals
 2. to evaluate the accuracy of SLR-based attitude estimation using true data (telemetry of HTV-X) → see next slide

3. Overview of Mt.FUJI Mission

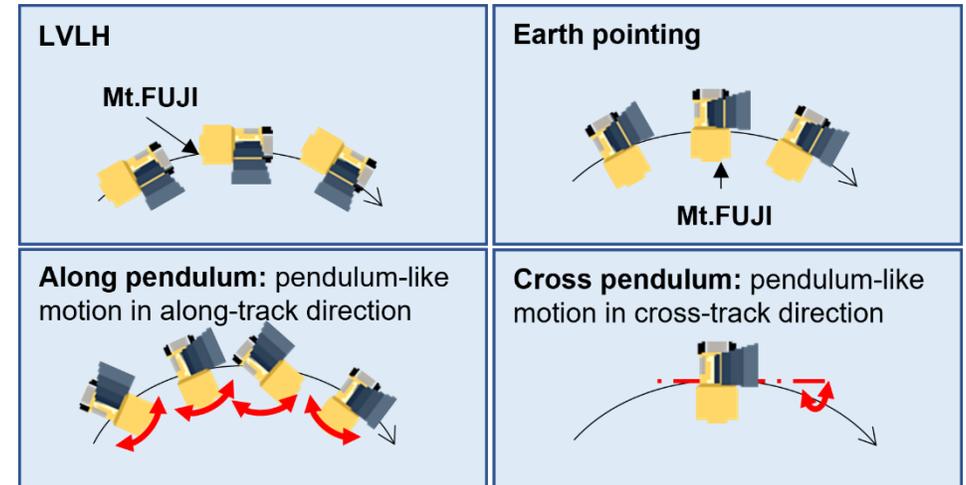


- To evaluate the accuracy of SLR-based attitude estimation using true data (telemetry of HTV-X),
 - (1) the HTV-X will fly in special attitude motion and downlink its telemetry including attitude states
 - (2) SLR is performed and obtain SLR data affected by attitude motion
 - (3) attitude estimation by obtained SLR data
 - (4) compare HTV-X telemetry data as true values (**world-first quantitative evaluation**)
- 4 different attitude will be taken in orbit:
 - LVLH: nominal attitude
 - Earth pointing: Mt.FUJI directs towards the Earth
 - Along/Cross pendulum: pendulum-like motion in along/cross – track direction
 - Space debris is considered to be flying in dynamic motion (like tumbling). This special attitude motion is kind of imitation of space debris motion. Such dynamic attitude motion cannot be achieved by ordinary spacecraft!

Many works stated that SLR can estimate a target attitude motion, but there was **no quantitative evaluation of the accuracy of the estimation by SLR.**



Operation overview in Mt.FUJI mission phase



Attitude motion in Mt.FUJI mission phase

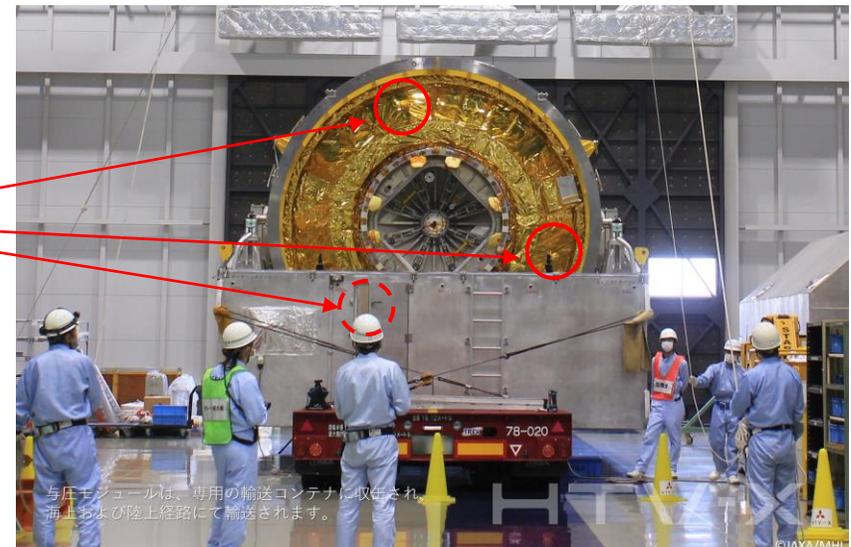
3. Overview of Mt.FUJI Mission



- Mission period: totally 4~5 weeks
 - 3 weeks in Mt.FUJI Mission phases which starts after 1~2 weeks later departing from the ISS (berthed duration is up to 6 months and difficult to predict now)
 - 1 ~ 2 weeks before ISS approaching or after complete of all demonstration missions.
- Restriction:
 - No restriction. HTV-X have STT, but HTV-X will not take attitudes that any SLR stations enter the field of view of the STT as long as SLR is preformed at the elevation over 20 degrees. Thus, there is no risk to violate the STT by SLR.
- Current status:
 - Complete Mt.FUJI attachment to the HTV-X
 - Complete development the pressurized module of the HTV-X



Mt.FUJI



4. To ILRS members



- To success Mt.FUJI mission, we need to obtain sufficient SLR data as many as possible. SLR is essential to achieve Mt.FUJI mission. We believe that ILRS members are interested in this mission, especially evaluating the absolute accuracy of attitude motion determination by SLR.
- If we can receive ILRS supports, we would like to plan the “Intercomparison event for HTV-X attitude motion estimation” within the ILRS.
 - Much more discussion and consideration is needed for this event, but if you are interested in the event, please let me know.
 - NOTE: we are currently confirming with the HTV-X project and the manufacturer whether or not the information necessary for estimation (including some HTV-X’s mechanical information, and orbital information, etc…) and true values is available to the public. If so, no problem. But if not, find another way(make joint research agreement?)
- We really appreciate it if we could receive the ILRS supports and perform the world-wide SLR campaign for Mt.FUJI mission!



thank you



(B/U) Overview of Mt.FUJI Mission



- Other information
 - HTV-X altitude: 380~500 km
 - HTV-X inclination: 51.3 degrees
 - HTV-X eccentricity: 0
 - HTV-X frequency of maneuvers: no orbital maneuvers in Mt.FUJI mission period